

Calculation Methodology

OVERVIEW

The Building Emissions Calculator expands on Portfolio Manager’s greenhouse gas (GHG) emissions capabilities by:

- Allowing users to create location-based and market-based GHG emissions estimates;
- Applying historic emissions factors to prior years’ energy consumption; and
- Forecasting of emissions based on a set of user-defined assumptions.

This document provides a technical overview of the calculation methodology underlying the Building Emissions Calculator (Calculator). The methodology is described in two main sections: (1) calculation of annual current/historical emissions for standard greenhouse gas (GHG) emission accounting categories; and (2) calculation of annual emissions for a forecast year based on user-specified assumptions, for the same accounting categories.

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CALCULATING CURRENT AND HISTORICAL EMISSIONS

The tables below provide a summary of how a building’s current and historical emissions are calculated for each emissions category. All default emissions factors, by fuel type and year, can be found in [Appendix A](#).

Direct Emissions		Indirect Emissions		
Default	with Locality Factors	Location-Based	Market-Based	with Locality Factors
Use national factors for all direct fuels	Use locality-specified factors for direct fuels where selected; else use national factors. <i>Calculated only if user selects locality-specified factors.</i>	Use eGRID subregion factor for grid electricity and national factors for district steam/hot water/chilled water. Offsite green power is assigned the grid electricity factor based on the eGRID subregion factor for the building’s location.	Use custom factors, as specified by user, for the % of fuel consumption specified by user. For any fuel use where no custom emissions factors are specified, apply eGRID subregion factors for electricity, and national factors for district energy. Offsite green power is treated as a zero-emissions fuel.	Use locality-specified factor where selected; else use Indirect (Location-Based) factors. Offsite green power is assigned the locality-specified emissions factor for grid electricity, if applicable; or the eGRID subregion factor for electricity for the building’s location. <i>Calculated only if user selects locality-specified factors.</i>

NOTES:

For each fuel type, calculated emissions are equal to the amount of consumption multiplied by the relevant emissions factor for that fuel type and year.

Indirect Fuels: Electricity, District Steam, District Hot Water, District Chilled Water

Direct Fuels: Natural Gas + All Other Fuel Types

	Direct Emissions		Indirect Emissions		
	Default	with Locality Factors	Location-Based	Market-Based	with Locality Factors
Total (Location-Based) Emissions	✓		✓		
Total (Market-Based) Emissions	✓			✓	
Total (with Locality Factors) Emissions		✓			✓

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Direct Emissions

Direct emissions are calculated by multiplying the annual consumption of each direct fuel type by the corresponding default emissions factor for that fuel type and year, and then summing the resulting emission totals.

Direct Emissions =

$$\sum (\text{Consumption of Each Direct Fuel} * \text{Corresponding National Default Emissions Factor for Fuel/Year})$$

Indirect (Location-Based) Emissions

Indirect (Location-Based) emissions are calculated by multiplying the annual consumption of each indirect fuel type by the corresponding emissions factor for that fuel type and year. For electricity, the emissions factor is the eGRID subregion factor for the consumption year; for all other indirect fuels, the emissions factor is the national default factor for that fuel type and year. Electricity generated via onsite renewable systems and consumed onsite is assigned an emissions factor of “0” (zero) unless the Renewable Energy Credits (RECs) have been sold, in which case the consumption amount is multiplied by the eGRID subregion factor for the consumption year.

Indirect (Location-Based Emissions) =

$$(\text{Total Grid Electricity Consumption} * \text{Corresponding eGRID Factor for Year})$$

+

$$(\text{Consumption of Electricity Generated Renewably Onsite, for which RECs Were Not Retained * Corresponding eGRID Factor for Year})$$

+

$$\sum (\text{Consumption of Each Non-Electric Indirect Fuel} * \text{Corresponding National Default Emissions Factor for Fuel/Year})$$

Indirect (Market-Based) Emissions

Indirect (Market-Based) emissions are calculated using the custom factor(s) entered by the Calculator user, as well as the percentage of total fuel-specific consumption that the user has indicated should receive the custom factor. Any excess consumption of an indirect fuel, beyond the percentage specified for application of the custom factor, is assigned the appropriate eGRID emissions factor or default national emissions factor. Electricity generated via onsite renewable systems and consumed onsite is assigned an emissions factor of “0” (zero) unless the RECs have been sold, in which case that consumption amount is multiplied by the eGRID subregion factor for the consumption year. Offsite Green Power is treated as a zero-emissions fuel source.

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Indirect (Market-Based) Emissions =

*(% of Grid Electricity Consumption Receiving Custom Factor * Total Electricity Consumption * Electric Custom Factor) + [(100% - % of Total Electricity Consumption Receiving Custom Factor) * Total Electricity Consumption * Corresponding eGRID Factor for Year]*

+

*(Consumption of Electricity Generated Renewably Onsite, for which RECs Were Not Retained * Corresponding eGRID Factor for Year)*

-

*(Total Consumption of Offsite Green Power * Corresponding eGRID Factor for Year)*

+

\sum *(% of Consumption of Each Non-Electric Indirect Fuel Receiving Custom Factor * Total Consumption of Each Non-Electric Indirect Fuel * Custom Factor for Each Non-Electric Indirect Fuel) + [(100% - % of Consumption of Each Non-Electric Indirect Fuel Receiving Custom Factor) * Total Consumption of Each Non-Electric Indirect Fuel * Corresponding National Default Emissions Factor for Each Fuel/Year]*

Direct (with Locality Factors) Emissions

Direct (with Locality Factors) emissions are calculated using the emissions factors specified by a given jurisdiction for designated direct fuel types.

Direct (with Locality Factors) Emissions =

\sum *(Consumption of Each Direct Fuel With Locality-Specified Emissions Factor * Corresponding Locality-Specified Emissions Factor for Each Fuel)*

+

\sum *(Consumption of Each Direct Fuel Without Locality-Specified Emissions Factor * Corresponding National Default Emissions Factor for Fuel/Year)*

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Indirect (with Locality Factors) Emissions

Indirect (with Locality Factors) emissions are calculated using the emissions factors specified by a given jurisdiction for designated indirect fuel types.

Indirect (with Locality Factors) Emissions =

$$\sum (\text{Consumption of Each Indirect Fuel [including electricity] With Locality-Specified Emissions Factor * Corresponding Locality-Specified Emissions Factor for Fuel})$$

+

$$\sum (\text{Consumption of Each Non-Electric Indirect Fuel Without Locality-Specified Emissions Factor * Corresponding National Default Emissions Factor for Fuel/Year})$$

+

*(Total Grid Electricity Consumption [if no locality-specific electric emissions factor is provided] * Corresponding eGRID Factor for Year)*

CALCULATING FORECAST EMISSIONS

The process of calculating emissions for the forecast year specified by the Calculator user requires two steps: (1) application of user-defined assumptions to latest year of baseline data; and (2) calculation of relevant emissions metrics.

Application of User-Defined Assumptions

When calculating forecast year emissions, the Calculator uses the most recent year of data for each building as the building's baseline year. The Calculator applies the user-defined forecast assumptions to the baseline year data to obtain estimated forecast year consumption data that is used to calculate the forecast year emissions. All data field names referenced in the documentation below (in *italics*) correspond to building-level data fields that are imported or input into the Calculator.

- Forecast Year Electricity Use (as a Percentage of Total Site Energy Consumption)
 - Multiply baseline year *Site Energy Use* by the forecast year anticipated percent electricity as input by the Calculator user.

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- Set forecast year *Electricity Use - Grid Purchase and Generated from Onsite Renewable System* to the product obtained above.
 - Update *Electricity Use – Grid Purchase* to reflect the new total electricity consumption minus the *Electricity Use – Generated from Onsite Renewable Systems and Used Onsite* from the baseline year.
 - For each non-electric fuel type, the forecast year consumption amount will be increased/decreased by an amount proportional to the contribution of that fuel type to the total non-electric fuel consumption in the baseline year. The total forecast year consumption of non-electric fuels will be equal to the baseline year *Site Energy Use* minus the new (forecast year) value for *Electricity Use - Grid Purchase and Generated from Onsite Renewable System*.
 - Carry these new building-level fuel use forecasts forward to the application of the next forecast assumption.
- Forecast Year Percent Site Energy Use Reduction
 - Multiply the latest value for *Site Energy Use* by the decimal value (1 – percent energy reduction input by user) to obtain a forecast for *Site Energy Use* that reflects anticipated energy reductions.
 - Divide the forecast for *Site Energy Use* by the building square footage to obtain a new *Site EUI*.
 - Take the latest values for each of the following and multiply by the decimal value (1 – percent energy reduction input by user) to get each fuel use forecast that reflect anticipated energy reductions:
 - *Electricity Use - Grid Purchase and Generated from Onsite Renewable Systems*
 - *Electricity Use - Grid Purchase*
 - *Electricity Use – Generated from Onsite Renewable Systems and Used Onsite*
 - *Natural Gas Use*
 - All other fuel-specific consumption values
 - NOTE: the Calculator assumes that the forecast percent reduction in energy consumption applies equally across all fuels consumed at the building.
 - Carry these new building-level fuel use forecasts forward to the application of the next forecast assumption.
 - Forecast Year Percent Offsite Green Power
 - Multiply the latest value for *Electricity Use - Grid Purchase and Generated from Onsite Renewable Systems* by the percent offsite green power input by the Calculator user
 - Convert this value to kWh and set as the new value for *Green Power – Offsite*.
 - Carry this new fuel use forecast forward to the application of the next forecast assumption.
 - Forecast Year Percent Onsite Green Power
 - Multiply the latest value for *Electricity Use - Grid Purchase and Generated from Onsite Renewable Systems* by the percent onsite green power input by the Calculator user; set this fuel use forecast for *Electricity Use – Generated from Onsite Renewable Systems and Used Onsite*.

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- Subtract the new value for *Electricity Use – Generated from Onsite Renewable Systems and Used Onsite* from the latest value for *Electricity Use - Grid Purchase and Generated from Onsite Renewable Systems*. Set this fuel use forecast for *Electricity Use - Grid Purchase*.
 - Convert the new value for *Electricity Use – Generated from Onsite Renewable Systems and Used Onsite* to kWh and set as the fuel use forecast for *Green Power – Onsite*.
 - Carry these fuel use forecasts forward to the application of the next forecast assumption.
- Forecast Year Emissions Rate
 - Take the value for the forecast year grid electric emissions, as input by the Calculator user, and set this as the forecast value for the *eGRID Output Emissions Rate*.

After all the above transformations have been applied, in the order noted, then there is a complete set of forecast year data that the Calculator can use to generate emissions metrics for the forecast year.

Calculation of Forecast Year Emissions

At this point in the Calculator process flow, the forecast year data for selected buildings are run through the emissions calculations documented above (in the “Calculating Current and Historical Emissions” section). Calculations for forecast year emissions will follow the logic described earlier, with a few exceptions:

- Emissions metrics using locality-specified factors will not be calculated and will be returned as N/A in the “Forecast Emissions” tab of the Calculator.
- The forecast electric emissions rate specified by the Calculator user is used to calculate both location-based and market-based indirect emissions. The difference between the market- and location-based calculations for the forecast year is intended to reflect the impact of offsite green power.
- It is presumed that, for all electricity generated renewably onsite and used onsite, the building owner will retain the RECs – and therefore the full amount can be considered *Onsite Green Power* and assigned an emissions rate of 0 (zero).

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APPENDIX A: CALCULATOR EMISSIONS FACTOR LOOKUP TABLES

Non-Electric Fuels

	Emissions Factor (kg CO ₂ e/MBtu)																						
	Publication Year of Emissions Factors (to align with building annual period ending dates)																						
Fuel Type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
District Steam	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	66.40	66.40	66.40	66.40	66.40	66.40	66.40	66.40	66.40
District Hot Water	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	88.54	66.40	66.40	66.40	66.40	66.40	66.40	66.40	66.40	66.40
District Chilled Water - Electric Driven Chiller	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70	52.70
District Chilled Water - Absorption Chiller using Natural Gas	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.86	73.89	73.89	73.89	73.89	73.89	73.89	73.89	73.89
District Chilled Water - Engine-Driven Chiller Natural Gas	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.29	49.31	49.31	49.31	49.31	49.31	49.31	49.31	49.31
Natural Gas	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.07	53.11	53.11	53.11	53.11	53.11	53.11	53.11	53.11	53.11
Fuel Oil (No. 2)	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21
Propane	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	61.50	64.25	64.25	64.25	64.25	64.25	64.25	64.25	64.25
Kerosene	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69	77.69
Fuel Oil (No. 1)	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50
Fuel Oil (No. 5 & No. 6)	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35	75.35
Coal (anthracite)	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.27	104.44	104.44	104.44	104.44	104.44	104.44	104.44	104.44	104.44
Coal (bituminous)	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.13	94.03	94.03	94.03	94.03	94.03	94.03	94.03	94.03	94.03
Coke	102.77	102.77	102.77	102.77	102.77	102.77	102.77	102.77	102.77	102.77	102.77	102.77	102.77	102.77	114.42	114.42	114.42	114.42	114.42	114.42	114.42	114.42	114.42
Fuel Oil (No. 4)	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29	75.29
Diesel	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21	74.21
Wood	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.77	95.05	95.05	94.22	94.22	95.05	95.05	95.05	95.05

Source for emissions factors:
 U.S Environmental Protection Agency Center for Corporate Climate Leadership GHG Emission Factors Hub, <https://www.epa.gov/climateleadership/ghg-emission-factors-hub>

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Electricity

Emissions Factor (kg CO2eq/MBtu)																							
Publication Year of Emissions Factors (to align with building annual period ending dates)																							
Subregion	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AKGD	164.17	164.17	164.17	164.17	164.17	164.17	164.17	171.17	171.17	170.66	167.46	167.46	169.05	169.05	123.58	123.58	143.21	143.21	138.92	148.99	148.99	148.99	148.99
AKMS	66.55	66.55	66.55	66.55	66.55	66.55	66.55	71.47	71.47	69.53	59.84	59.84	64.16	64.16	90.80	90.80	67.11	67.11	70.05	73.27	73.27	73.27	73.27
AZNM	175.06	175.06	175.06	175.06	175.06	175.06	175.06	167.26	167.26	159.07	157.24	157.24	153.93	153.93	116.95	116.95	139.45	139.45	136.60	127.22	127.22	127.22	127.22
CAMX	96.69	96.69	96.69	96.69	96.69	96.69	96.69	90.87	90.87	87.90	81.54	81.54	86.77	86.77	75.83	75.83	70.44	70.44	66.29	60.52	60.52	60.52	60.52
ERCT	176.72	176.72	176.72	176.72	176.72	176.72	176.72	167.14	167.14	157.68	162.56	162.56	152.50	152.50	152.60	152.60	134.81	134.81	124.44	115.98	115.98	115.98	115.98
FRCC	176.12	176.12	176.12	176.12	176.12	176.12	176.12	162.95	162.95	157.08	159.77	159.77	150.20	150.20	143.65	143.65	135.11	135.11	124.45	114.92	114.92	114.92	114.92
HIMS	204.30	204.30	204.30	204.30	204.30	204.30	204.30	179.92	179.92	180.45	177.63	177.63	160.25	160.25	125.94	125.94	154.03	154.03	148.76	158.96	158.96	158.96	158.96
HIOA	242.18	242.18	242.18	242.18	242.18	242.18	242.18	216.58	216.58	213.00	216.83	216.83	210.70	210.70	198.10	198.10	222.70	222.70	223.68	226.99	226.99	226.99	226.99
MROE	245.20	245.20	245.20	245.20	245.20	245.20	245.20	226.26	226.26	212.77	215.31	215.31	203.52	203.52	222.84	222.84	223.24	223.24	224.61	201.12	201.12	201.12	201.12
MROW	243.51	243.51	243.51	243.51	243.51	243.51	243.51	230.30	230.30	217.72	205.38	205.38	190.53	190.53	182.84	182.84	165.83	165.83	166.06	147.09	147.09	147.09	147.09
NEWE	124.29	124.29	124.29	124.29	124.29	124.29	124.29	110.91	110.91	97.61	96.75	96.75	85.44	85.44	76.66	76.66	74.94	74.94	70.13	65.65	65.65	65.65	65.65
NWPP	120.60	120.60	120.60	120.60	120.60	120.60	120.60	114.78	114.78	109.46	112.58	112.58	88.96	88.96	121.41	121.41	87.13	87.13	85.53	95.70	95.70	95.70	95.70
NYCW	108.74	108.74	108.74	108.74	108.74	108.74	108.74	93.91	93.91	81.36	82.93	82.93	92.80	92.80	88.65	88.65	84.69	84.69	79.46	73.77	73.77	73.77	73.77
NYLI	205.40	205.40	205.40	205.40	205.40	205.40	205.40	189.40	189.40	179.97	178.30	178.30	160.31	160.31	160.08	160.08	157.66	157.66	158.60	162.04	162.04	162.04	162.04
NYUP	96.35	96.35	96.35	96.35	96.35	96.35	96.35	91.29	91.29	66.51	72.90	72.90	54.54	54.54	48.87	48.87	39.34	39.34	33.75	31.02	31.02	31.02	31.02
PRMS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	205.16	205.16	205.16	205.16
RFCE	152.27	152.27	152.27	152.27	152.27	152.27	152.27	141.60	141.60	126.64	133.87	133.87	114.68	114.68	110.92	110.92	101.31	101.31	95.71	92.85	92.85	92.85	92.85
RFCM	209.01	209.01	209.01	209.01	209.01	209.01	209.01	220.74	220.74	221.84	217.77	217.77	209.68	209.68	205.04	205.04	170.01	170.01	175.63	159.12	159.12	159.12	159.12
RFCW	205.52	205.52	205.52	205.52	205.52	205.52	205.52	207.38	207.38	203.23	200.91	200.91	184.32	184.32	184.87	184.87	166.36	166.36	156.07	142.82	142.82	142.82	142.82
RMPA	251.55	251.55	251.55	251.55	251.55	251.55	251.55	254.65	254.65	243.72	253.39	253.39	243.51	243.51	232.53	232.53	183.02	183.02	170.41	166.25	166.25	166.25	166.25
SPNO	262.04	262.04	262.04	262.04	262.04	262.04	262.04	240.38	240.38	242.63	240.42	240.42	230.04	230.04	210.87	210.87	189.06	189.06	155.75	143.25	143.25	143.25	143.25
SPSO	221.41	221.41	221.41	221.41	221.41	221.41	221.41	216.89	216.89	213.53	211.03	211.03	205.43	205.43	197.36	197.36	166.81	166.81	155.90	133.84	133.84	133.84	133.84
SRMV	136.11	136.11	136.11	136.11	136.11	136.11	136.11	134.01	134.01	133.75	137.40	137.40	140.47	140.47	136.52	136.52	111.95	111.95	114.11	107.64	107.64	107.64	107.64
SRMW	244.63	244.63	244.63	244.63	244.63	244.63	244.63	237.81	237.81	233.85	241.97	241.97	228.61	228.61	237.36	237.36	215.68	215.68	222.90	212.18	212.18	212.18	212.18
SRSO	199.12	199.12	199.12	199.12	199.12	199.12	199.12	199.89	199.89	177.15	180.92	180.92	153.45	153.45	152.95	152.95	145.58	145.58	137.38	129.48	129.48	129.48	129.48
SRTV	201.88	201.88	201.88	201.88	201.88	201.88	201.88	205.95	205.95	181.45	185.63	185.63	178.66	178.66	178.83	178.83	158.54	158.54	138.00	127.06	127.06	127.06	127.06
SRVC	151.73	151.73	151.73	151.73	151.73	151.73	151.73	149.53	149.53	138.48	143.50	143.50	124.68	124.68	114.68	114.68	107.69	107.69	99.37	90.30	90.30	90.30	90.30

Source for emissions factors:

U.S. Environmental Protection Agency Emissions & Generation Resource Integrated Database (eGRID), <https://www.epa.gov/egrid>

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New York City Emissions Factors for Local Law 97

The Calculator references the following for the application of “Locality-Specified Factors” to be used in demonstrating compliance with New York City Local Law 97. Further details can be found at <https://www.urbangreencouncil.org/content/nyc-building-emissions-law-frequently-asked-questions> (see FAQ number 14, which is captured below). The values in the table below are multiplied by 1,000 to translate kg CO₂e/kBtu to kg CO₂e/MBtu.

14. HOW MUCH CARBON COMES FROM EACH TYPE OF ENERGY?

The building emissions law sets specific emissions factors for the 2024-2029 limits. It also requires that emissions factors applicable for the 2030 limits be set by rule no later than January 1, 2023.

For the 2024-2029 limits, the law sets electricity as the most carbon-intensive energy source per unit of on-site energy. These coefficients, except for district steam, align with the coefficients used in the **EPA's Portfolio Manager** and the **EPA eGRID 2016 coefficients**, shown in the table below:

Energy Source	2024 Carbon Intensity Factors (kg of CO ₂ e per kbtu)	EPA Carbon Intensity Factors (kg of CO ₂ e per kbtu)	Percent Difference from EPA
Electricity (NYC)	.08469	.0847	equivalent
No. 4 Fuel Oil	.07529	.07529	equivalent
No. 2 Fuel Oil	.07421	.07421	equivalent
Natural Gas	.05311	.05311	equivalent
District Steam	.04493	.0664	32.3% lower

Owners will also have the option to calculate electricity carbon intensity based on time of use. Further details will be specified in Department of Buildings rules.